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ABSTRACT

The Connecticut State Department of Education has established three levels of educational technology competencies for teachers. Over the past several years researchers at the University of Connecticut had developed a number of performance assessments to measure the extent to which teachers possess these educational technology competencies. This report describes the development and validation of an early version of the Level 1 technology assessment. Level 1 competencies include basic computer skills and the use of typical productivity software. It also describes how technology competence or accuracy scores related to teachers self-efficacy concerning the tasks assessed by the performance measure as well as their interest in the use of technology. Data were obtained from 61 teachers from 2 metropolitan school districts. Scores from the Level 1 performance measure have been found to be a valid and reliable means of assessing teacher educational technology competence. The measure has also been well-received by teachers. The research has uncovered significant positive correlations between educational technology competency and self-efficacy as expected. Unexpected, however, are the low correlations between interest scores and both teacher competency and self-efficacy. Differences were also found between the correlations of technology competency and self-efficacy scores taken before and after the technology competency measure was administered. Correlations are generally higher at posttest than at pretest, implying that teachers assessments of their own technology skills align more closely with the performance measure of these skills after they have taken an assessment designed to measure these skills. (Contains 5 tables and 22 references.) (Author/SLD)

Running Head: TEACHER COMPETENCY IN EDUCATIONAL TECHNOLOGY

Developing Performance Assessments to Measure Teacher Competency in the Use of Educational Technology

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Abstract

The Connecticut State Department of Education has established three levels of educational technology competencies for teachers. Level I competencies include basic computer skills involving the use of a microcomputer operating system as well as typical productivity software such as the Microsoft Office Suite. Level II competencies focus on teachers' familiarity with a broad range of educational technologies as well as the learning theory and pedagogical issues associated with the application of those technologies. Level III competencies focus on teachers' proficiency in integrating technology into classroom instruction, ethical and social issues surrounding the use of technology, and the impact that technology has on student productivity. Over the past several years researchers at the University of Connecticut have developed a number of performance assessments to measure the extent to which teachers possess these educational technology competencies. The research presented herein describes the development and validation of an early version of the Level I Technology Assessment. It also describes how technology competency or accuracy scores relate to teachers' self-efficacy concerning the tasks assessed by the performance measure as well as their interest in the use of technology. Scores obtained from the Level I performance measure have been found to be a valid and reliable means of assessing teacher educational technology competency. It has also been well received by teachers. Our research has also uncovered significant positive correlations between educational technology competency and self-efficacy, as expected. Unexpectedly, however, low correlations were found between interest scores and both teacher competency and self-efficacy. Differences were also found between the correlations of technology competency, on the one hand, and self-efficacy scores taken before and after the technology competency measure was administered. Further, the correlations are generally higher at post-test than at pre-test implying that teachers' assessments of their own technology skills align more closely with a performance measure of these skills after taking an assessment designed to measure the skills

Introduction

Elementary and secondary schools in the United States are spending upwards of $5 billion per year on computer hardware and software. Despite these expenditures, educators and policy makers are concerned that technology is not being effectively integrated into our nations' schools (International Society for Technology in Education, 1998; Marcinkiewicz, 1996; Putnam & Borko, 2000). A primary reason for this disappointing state of affairs is that teachers have not been adequately prepared to use technology, particularly those experienced teachers who were licensed before educational technology use became an important part of the teacher preparation process (Marx, Blumenfeld, Krajcik & Soloway, 1998). In fact, Moursund and Bielefeldt (1999) reported that less than 50% of public school teachers in their survey are sufficiently well qualified in educational technology use to advise pre-service teachers assigned to them. Bailey and Pownell (1997) have spoken to the importance of staff development when attempting to integrate technology into classroom environment. Milone (1998) has even more strongly argued that effective professional development is vital if technology is ever to be used in intelligent ways with children.

The State of Connecticut took significant steps in 1999 to improve the educational technology competency of its teachers by adopting a three-level model of educational technology competency, by providing professional development to improve the skills and competencies specified in that model, and by providing some support for the development of performance assessments to measure the extent to which the skills and competencies specified in the model had been acquired. The three-level model of educational technology competency, which is grounded in the International Society for Technology in Education (ISTE) (2000) standards and is similar to models developed in states like Colorado (Colorado Department of Education, 1999), forms a hierarchy of skills. Level I competencies included basic computer skills involving the use of a computer operating system, typical productivity software such as the Microsoft Office Suite, and the use of the Internet. Level II competencies focused on the teacher's familiarity with a broad range of educational technologies (e.g., probes, robotics, and software) as well as the learning theory (e.g., constructivism and situated cognition) and pedagogical issues associated with the application of technology. Level III competencies focused on the teacher's proficiency in integrating technology into classroom instruction and the impact it had on student productivity. This three-level model was modified in 2001, as described below.

The research described herein presents information on the development and validation of the original Level I performance assessment and the relationship between the derived performance scores and teachers reported self-efficacy about those same skills and their interest in using productivity software, educational software and other learning technologies. The goal of this assessment was to certify that individuals possessed a demonstrated proficiency with Level I technology skills and competencies prior to entering Level II training.

Methodology

Technology Assessment

Performance Assessment.
Airasian (1996) classifies assessment approaches under the headings selection, supply, product or performance. Multiple choice, true-false and matching items are listed as selection procedures; completion, labeling a figure or diagram, short answer and concept maps are considered supply procedures; essays, research reports, portfolios, diaries and journals, projects and exhibits are listed as products; and dramatic performances, lab demonstrations, and oral presentations are considered performance measures. Early assessments of teacher technology competency relied heavily on the use of selection and supply procedures. More recently, technology assessment has included various types of performance measures, which, according to Airasian, are "assessments in which pupils carry out an activity or produce a product in order to demonstrate their knowledge and skill" (2001, p. 228). Performance assessments also permit those taking the assessment to show what they can do in a real life situation (Wiggins, 1993). As a result, performance assessment is sometimes also called authentic assessment. However, Nitko (2001) has pointed out that these two terms are not interchangeable. He suggests that authentic assessment "usually means presenting students with tasks that are directly educationally meaningful rather than indirectly meaningful" (Nitko, 2001, p. 245). He goes on to state that four features should be present for an assessment to be considered authentic: (1) the assessment should emphasize application; (2) it should focus what is being assessed directly, not indirectly, (3) it should present realistic problems; and (4) it should encourage open-ended thinking.

Performance and authentic assessment procedures are being used increasingly in assessing all types of behaviors and educational outcomes. Such increased use results from certain advantages that performance assessment has over other assessment approaches, including that it is consistent with the highly regarded constructivist learning theory. This theory "emphasizes that students should use their previous knowledge to build new knowledge structures, be actively involved in exploration and inquiry through task-like activities, and construct meaning for themselves from educational experience (Nitko, 2001, p. 262). Despite its popularity, it should be noted that performance assessment does have disadvantages, including the complexity of developing high-quality tasks and scoring rubrics, the amount of time required to take and score these assessments, the lower reliability of such measures in comparison with more traditional assessment procedures, and validity concerns that are sometimes associated with the inability of performance assessment to effectively sample from a broad body of content.

Description of the Assessment Tasks
The Level I Technology Assessment described herein is a performance assessment. It was designed to measure an individual's competency with the Microsoft Windows operating system, Microsoft Office applications of Word, Excel and PowerPoint, the Internet and an E-mail client. The design taxonomy included the knowledge of commands (knowing location and availability), comprehending how to use these

commands, and knowing how to organize/synthesize a sequence of commands to accomplish a specific task. The design also called for the assessment to be consistent with constructivist learning theory and be authentic (McMillan, 2001). That is, the assessment had to have a context that was consistent with how teachers would use the technology in their classrooms. In this vein the word processing tasks involved the writing of a memo, the spreadsheet tasks involved the construction of a spreadsheet for recording grades, and the presentation tasks involved the development of a lesson presentation. The assessment required participants to sit at a computer and complete specific tasks that are saved to disk and submitted for evaluation. System tasks included the formatting of a disk and finding files. Word processing tasks included changing the font, using the spell checker and thesaurus, moving text, and inserting a graphic and a table. Spreadsheet tasks included inserting columns and rows, changing fonts, entering information, calculating totals, calculating averages, and sorting data. The presentation tasks included inserting new slides, modifying color and background, changing fonts, ordering slides, organizing information, and using the spellchecker. Internet and E-mail tasks require participants to navigate on the World Wide Web, complete a survey and send an e-mail message with an attachment.

As noted above, the form of the assessment discussed in this paper is an early version of the Level I Technology Assessment. An updated version of this instrument, which is now being used to collect data from a large sample of Connecticut teachers, assesses additional issues such as ethics and social concerns. Some of the tasks described above have also been changed. Our use of performance assessment to measure educational technology skills of teachers is consistent with procedures used in Idaho (Strickland, Salzman & Harris, 2000) and other states and with the new performance-based standards adopted by the National Council for Accreditation of Teacher Education (NCATE) (Mitchell, 2002). Information on the current Connecticut educational technology competencies is available at http://www.state.ct.us/sde/dsi/technology/CTTCt.pdf.

Content Validity. The content validity of the assessment instrument was determined in several ways. First, the instrument was designed to be consistent with ISTE Standards and with the various teacher certification standards adopted by the State of Connecticut. Second, although the researchers were primarily responsible for instrument development, a variety of other individuals and experts were also involved in the conceptualization of the assessment and the item development process. These individuals included university faculty responsible for undergraduate and graduate level instruction either in technology or assessment, representatives from the Connecticut State Department of Education, and a variety of public school personnel. Third, the instrument was piloted with pre-service teachers at the University of Connecticut and in-service teachers involved in professional development programs conducted by the University. Fourth, the validity of the task classification system was determined by asking three content experts to determine whether the assessment tasks involved word processing, spreadsheet operations, presentation operations, Internet and E-mail operations or the computer operating system. All three experts agreed with the researcher's classification of all tasks. And fifth, the validity of the assigned scores was assessed using factor analysis, as described below.

Similar procedures were followed in designing the two other instruments included in this research.

Task Accuracy. An accuracy score was derived for the assessment utilizing a rubric consisting of a series of questions answered on a dichotomous (Yes/No) scale. The number of questions varies by task depending on complexity. Consider, for example, the spreadsheet task that asks a participant to create a column, enter "Total Points" as the column title, and use an appropriate formula to calculate the total points obtained by each individual student. The accuracy rubric for this task contains four evaluation questions:

Have the student scores been totaled?
Are the total scores correct?
Were correct formulae used to calculate the total scores?
Was the Sum ( ) function used to calculate the scores?

The entire accuracy rubric contains tasks and questions as follows:

The operating system component contains 4 tasks evaluated with 5 questions.
The word processing component consists of 6 tasks evaluated with 11 questions.
The spreadsheet component consists of 7 tasks evaluated with 25 questions.
The PowerPoint component consists of 5 tasks evaluated with 10 questions.
The Internet and E-mail component has 3 tasks evaluated with 4 questions.

The accuracy score for each component is calculated by adding the number of "Yes" responses derived from application the rubric and dividing that number by the number of possible points to arrive at a percentage score. Accuracy ratings are assigned by judges who are familiar with the technology and trained in the use of the instrument.

Self-Efficacy Survey

The assessment also requires participants to complete a pre-training and post-training confidence survey based on Bandura's (1997) self-efficacy theory. According to Bandura (1989), higher levels of perceived self-efficacy are associated with higher levels of performance and higher task commitment when faced with tasks of increased difficulty. Further, although increases in self-efficacy may result from actually performing a task, they may also be achieved vicariously. Bandura has also shown that the higher one's beliefs in one's capabilities, the higher the goals one sets for oneself and the greater commitment one has to them. Self-efficacy has been the focus of a wide variety of studies that have demonstrated a strong link between this construct and behavior of various kinds, including phobias, weight loss, smoking cessation, and a number of others outcomes. (Bandura, 1997; Bandura, O'Leary, Taylor, Gauthier & Gossard, 1987; Bandura, Taylor, Williams, Mefford & Barhcas, 1985; Dzewaltowski, 1994; Strecher et al., 1986).

The survey used in the present research was developed by the researchers and asks participants to indicate the degree of confidence they have in performing specific educational technology tasks on a 5-point Likert scale ranging from 1 indicating very little confidence to 5 indicating a great deal of confidence. The items on the SE survey are consistent with the tasks on the performance assessment. The survey was administered before (pre) and after (post) the administration of the accuracy measure in one sitting.

Interest Survey

Participants are also required to complete an interest survey that includes items concerning the use of productivity software, the use of educational software, and the use of other learning technologies. They are asked to indicate their degree of interest on a 5-point Likert scale ranging from 1 indicating very little interest to 5 indicating a great deal of interest. Again, the items on the interest survey are consistent with the tasks on the performance assessment.

Administration of the Assessment

The data reported here were obtained from 61 teachers from two large metropolitan districts within Connecticut. The assessment was conducted in a computer lab setting by the researchers and individuals trained by them in the use of the instruments. Participants were administered the assessment tasks in a group format of 10-15 individuals. Each participant had his or her own computer loaded with the appropriate software and connected to the Internet. Participants were allowed to use the help functions during the assessment but they were not allowed to talk with one another. The assessment tasks could be completed in any order except for the pre-survey that was completed first and the post-survey that was completed last. A total of two hours was available for the assessment.

Results

Task Accuracy

To support the validity of the accuracy scores, the data were factor analyzed. The Internet/Email accuracy score was eliminated from further analysis because of low communality estimates (less than .01). The construct validity of the remaining four accuracy scores was investigated using Common Factor Analysis with an oblique rotation. A single factor, named Level I Technology Competency, emerged explaining 56% of the common variance. Loadings ranged from .58 for the Word or word processing accuracy score to .93 for the Excel or spreadsheet score. Despite these high correlations and the single factor solution, four separate subscale scores will be used in the analyses that follow to enable direct comparisons with the self-efficacy and interest scores described below.

Self-Efficacy

Common Factor Analysis yielded three highly similar factors for the pre and post confidence surveys (See Table 1). These factors were labeled (1) Confidence Using the Windows Operating System and Microsoft Word, (2) Confidence using Microsoft Excel, and (3) Confidence Using Microsoft PowerPoint. High relationships among the factors were noted with correlations ranging from .54 to .58 (See Table 2).

Table 1
Common Factor Analysis with Oblique Rotation: Pre-Assessment Confidence in Using Technology

Factor	Item Number	Stem	Loading
	3	Saving files to the A drive	.94
Factor I	2	Locating files on the C drive	.91
Confidence using the	1	Formatting Disks	.70
Windows Operating	6	Using the cut and paste features within a Microsoft Word document	.66
System and Microsoft		Using the spell checker in a Microsoft word document	
Word	7	Inserting objects into a Microsoft	.63
	4	Using the thesaurus in a Microsoft word document	.62
	8		.60
Factor II	10	Creating formulas in a spreadsheet	.92
Confidence using	11	Using functions in a Microsoft Excel spreadsheet	.87
Microsoft Excel	12	Sorting data in a Microsoft Excel spreadsheet	.78
	9	Inserting rows and columns in a spreadsheet	.64
Factor III Confidence using Microsoft PowerPoint	14	Entering information onto a slide in Microsoft PowerPoint Presentation.	.97
	16	Reordering slides in a Microsoft PowerPoint presentation	.93
	15	Inserting new slides into a Microsoft PowerPoint presentation.	.91
	18	Modifying the color scheme and background in a Microsoft PowerPoint presentation	.89
	17	Using the spellchecker in a Microsoft PowerPoint Presentation.	.77
	19	Organizing information using subordination in a Microsoft PowerPoint presentation.	.63

Table 2
Pre-Assessment Confidence in Using Technology: Factor Intercorrelation Matrix

	Confidence using the Windows Operating System and Microsoft Word	Confidence Using Microsoft Excel	Confidence using Microsoft PowerPoint
Confidence using the Windows Operating System and Microsoft Word	1.00		
Confidence using Microsoft Excel	.54	1.00	
Confidence using Microsoft PowerPoint	.58	.58	1.00

Interest

Common Factor Analysis with an oblique rotation yielded three factors for the interest survey with 60% of the common variance extracted. These factors were labeled (1) Interest in Advanced Software, (2) Interest in Productivity Software, and (3) Interest in Technology Tools (See Table 3). Interco relations among the factors ranged from -.39 (Productivity and Technology Tools) to .25 (Productivity Software and Advanced Software) (See Table 4).

Table 3
Common Factor Analysis with Oblique Rotation: Technology Interest Survey

Factor	Item Number	Stem	Loading
Factor I	7	Using Computer Aided Design	.79
Interest in	8	Using Robotics	.77
advanced	9	Using Statistical software applications	.77
Software	6	Using PROBEWARE	.65
	3	Using Spreadsheets in excel	.55
Factor II	4	Using World Wide Web searches.	.93
Interest in	5	Using Internet/Email correspondence	.74
productivity	1	Performing word processing with Word.	.65
software	2	Building presentations with PowerPoint	.58
Factor III			
Interest in	13	Using Distance Learning/Dynacom.	.75
technology	11	Using Hypertext/hypermedia	.51
learning tools	12	Using laserdisks	.51

Table 4
Technology Interest Survey: Factor Intercorrelation Matrix

	Interest in advanced Software	Interest in Productivity Software	Interest in Technology learning Tools
Interest in advanced software	1.00		
Interest in Product. software	.25	1.00	
Interest in Tech. learning tools	-.39	-.06	1.00

Reliability of Measures.

Coefficient Alpha measures of reliability were calculated to determine the internal consistency of all the scales. The accuracy measure was found to have an alpha reliability of .78. Alphas for the three confidence scales (pre-test) were .95, .91 and .96, respectively. Alphas for the three interest scales were .83, .76 and .77, respectively.

Intercorrelation of Measures

The zero-order correlations among all the measures are shown in Table 5. As can be seen in that table, each of the four accuracy scores correlated significantly with each of the other accuracy scores with correlations ranging from .29 to .67. Such significant correlations should be expected given the single-factor solution derived described above. Like the accuracy scores, the interest scores also correlated highly among themselves with the correlations ranging from .34 to .66, and, as was the case for accuracy, this result was also not unanticipated. However, the low correlation of interest with the other measures was not expected. Significant correlations were also found among the three self-efficacy (confidence) measures at both the pre-test and post-test with the correlations themselves ranging from .45 to .82. Again, significant correlations were not unexpected, as were the generally significant correlations between accuracy scores and self-efficacy scores addressing the same skills. What was unexpected is the difference between the correlations of accuracy scores and self-efficacy as measured on the pre-test and the post-test. As can be seen in Table 5, the correlations are almost always higher at post-test than at pre-test, implying that one's assessment of one's own technology skills align more closely with a performance measure of these skills after taking an assessment designed to measure those skills. Interestingly, teachers in this sample also had more trouble responding favorably to the confidence items on the pre-test than the post-test.

Table 5
Level I Technology Assessment Measures Intercorrelation Matrix

		Accuracy Scores				Pre-Assessment Confidence			Post-Assessment Confidence		
		Word	Excel	Power Point	Sys	Word	Excel	Power Point	Word	Excel	Power Point
Accuracy Scores	Word	1.00									
	Excel	0.52**	1.00								
	Power Point	0.29*	0.63**	1.00							
	Sys	0.48**	0.58**	0.67**	1.00						
Pre-Assessment Confidence	Word	0.19	0.30*	0.47**	0.34**	1.00					
	Excel	0.20	0.43**	0.52**	0.22	0.66**	1.00				
	Power Point	0.19	0.31*	0.50**	0.42**	0.69**	0.66**	1.00			
Post-Assessment Confidence	Word	0.32*	0.48**	0.53**	0.47**	0.82**	0.55**	0.58**	1.00		
	Excel	0.23	0.61**	0.54**	0.34**	0.60**	0.67**	0.45**	0.78**	1.00	
	Power Point	0.18	0.51**	0.71**	0.53**	0.64**	0.57**	0.81**	0.70**	0.66**	1.00
Interest Scores	Adv Sftwre	-0.03	0.01	0.08	0.08	0.09	-0.04	0.07	0.17	0.05	0.11
	Prod Sftwre	0.04	0.00	0.21	0.08	0.05	0.12	0.11	0.04	0.11	0.09
	Learn Tools	-0.12	-0.12	0.07	0.03	0.06	-0.12	0.08	-0.04	-0.07	0.12

		Interest Scores		
		Adv Sftwre	Prod Sftwre	Learn Tools
Interest Scores	Adv Sftwre	1.00		
	Prod Sftwre	.34*	1.00	
	Learn Tools	0.41**	.66**	1.00

Discussion

Increasing teacher use of technology is a pressing national concern that will be reduced, and hopefully even eliminated, only by improving the professional development of teachers and by developing measures that objectively verify that professional development has had its intended impact. The research reported herein describes the development of a performance assessment of teacher technology competency and the validation of that assessment using a variety of procedures. Because these initial validation results proved so encouraging, and because teachers who took the assessment have testified repeatedly to its quality and perceived validity, a number of districts in Connecticut are now using the instrument to assess whether their teachers are indeed technology competent. This endorsement of the instrument by several large and influential school districts points to the need for a device like ours as well as the importance that school districts are beginning to place on being able to validate that their teachers are technology competent. Such an instrument might also prove useful to schools, colleges and departments of education as they respond to the new performance-based criteria adopted by NCATE.

With regard to self-efficacy, it is interesting to note that the mean scale scores for teachers' perceived competency in using technology improved from pre-test to post-test, as did the correlation between actual performance and self-efficacy. These findings are consistent with those of Bandura (1997) and others who have shown that personal experience with a specific task can positively impact a person's self efficacy, which in turn can then impact task commitment, motivation and final success. In this case, the personal experience through which teachers became more familiar with the task was the technology assessment. Although the goal of this process was to assess educational technology competency, we may have found that the assessment process itself positively impacts perceived educational technology competency. This finding is consistent with research on authentic assessment (Nitko, 2001) and provides encouragement to us as we attempt to seamlessly transition in-service teachers from educational technology training to assessment to classroom implementation.

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